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First record of the southwestern Indian Ocean endemic *Apolemichthys kingi* (Teleostei: Pomacanthidae) from Sainte Marie Island, Madagascar

by

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Résumé. – Premier signalement dans le sud-ouest de l'océan Indien d'*Apolemichthys kingi* (Teleostei : Pomacanthidae), sur les côtes de l'île Sainte-Marie, Madagascar.

Considéré jusqu'à présent comme endémique de la zone frontalière entre l'Afrique du Sud et le Mozambique, *Apolemichthys kingi* est signalé pour la première fois sur la côte nord-est de Madagascar (île Sainte-Marie) à 34 m de profondeur. La présence de cette espèce à Madagascar a été corroborée par les informations présentes dans la base BOLD concernant un individu à la morphologie similaire, capturé en 2013 sur la côte sud-est de Madagascar (Fort Dauphin). Ces observations confirment l'extension de l'aire de répartition de l'espèce à l'Est de Madagascar et renforcent l'hypothèse d'une connectivité larvaire entre le continent africain et l'Est de la grande île. La présente note souligne aussi l'importance de la prospection des habitats récifaux profonds des îles du sud-ouest de l'océan Indien pour une meilleure compréhension de la biodiversité et des fonctionnalités écologiques de ces habitats méconnus.

Key words. – Pomacanthidae – *Apolemichthys kingi* – Madagascar – Sainte Marie Island – Endemism – Range extension.

The study of marine and freshwater ichthyological diversity from Madagascar dates back to the late 18th century (Sauvage, 1887, 1891a; Fourmanoir, 1957; Fischer and Bianchi, 1984) and allowed the identification of 1,798 species belonging to 247 families (Fricke *et al*., 2018). The area covered by this most recent checklist of the fish fauna of Madagascar includes the waters of the EEZ of Madagascar (marine and freshwater species), but excludes the Eparses Islands in Mozambique Channel (*e.g.* see Fricke *et al*., 2013), the Comoros and Mayotte (see Wickel *et al*., 2014), and Walters Shoals on the Madagascar Ridge (Colette and Parin, 1991). However, due to the progress of determination tools, observation of deeper environments and larger sampling efforts, inventories continue to be enriched over time, so that new observations or descriptions of species are still quite common. The present paper is about the observation, during an environmental survey on the Sainte Marie Island, west coast of Madagascar, of *Apolemichthys kingi* Heemstra, 1984, a species that had not previously been officially recorded from Madagascar. As *A. kingi* was previously known as restricted to Natal, South Africa and Mozambique, this study offers the opportunity to extent the range of distribution of the species.

MATERIALS AND METHODS

The specimen described in this study was photographed during an environmental survey in Madagascar using underwater visual censuses (UVC) on 1st Feb. 2018 at 2:00 PM. The observation took place on Sainte Marie Island Southwest shore (17.041031°S; 49.821080°E), at 34 m depth and water temperature of 26°C (Fig. 1B).

The photographed specimen has been identified following the Western Indian Ocean Angelfishes Classification (Heemstra, 1984). The size of the individual was estimated *in situ* taking into account the overestimation underwater of the fish (Edgar *et al*., 2004). Body parameters such as standard length (SL), head length (HL), body depth (BD) and orbit diameter (OD) were estimated on photographic basis, and percentages of the standard length were calculated.

Its identification as the Tiger angelfish *Apolemichthys kingi* was also assessed by comparing the Cytochrome c oxidase subunit I (COI) sequence of a similar-looking specimen (Fig. 1C) caught in 2013 by S. Fennessy and B. Mann, South African Institute for Aquatic Biodiversity, north of Tôlanaro (Fort Dauphin), southeastern Madagascar, to the COI sequences of four specimens identified as *A. kingi* originating from South Africa. The five COI sequences, and their respective associated Barcode Index Number (BINs), were retrieved from the Barcode of Life Data System (http://v4.boldsystems.org). A unique BIN would mean that these sequences belong to the same cluster and thus correspond to only one operational taxonomic unit (OTU, Ratnasingham and Hebert, 2013), each OTU closely corresponding to a species.

RESULTS

The photographed specimen had an estimated TL of 20.0 cm, a SL of 17.2 cm, a HL of 5.1 cm, a BD of 9.1 cm and an OD of 1.3 cm. The HL was 29.6%, the BD 52.9% and the OD 7.6% of SL. Dorsal half of body with alternating, wavy, vertical stripes of black and orange-yellow. Anteriorly, the black stripes break up into several small black spots on the nape. Ventral part of the body, pelvic and anal fins are pale grey. Caudal and dorsal fins present narrow white edge, and preopercle spine and lips are bluish grey (Fig. 1B).

In the field, this specimen was solitary, swimming close to the sea bottom, and feeding on small invertebrates from the substrate. The benthic habitat on the area was characterized by a 20 m diam-

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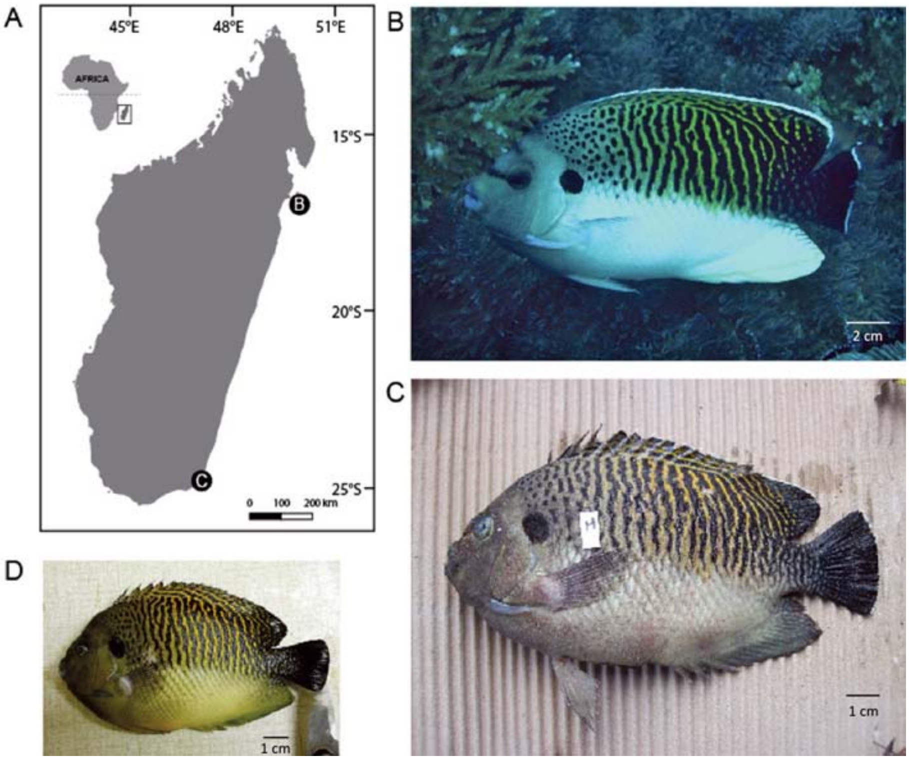

Figure 1. – Map of Madagascar (**A**) with the locations where the specimen of *Apolemichthys kingi* was photographed in 2018 (Sainte Marie Island, site B) and identified in 2013 (north of Tôlanaro, site C). Image of the specimen photographed in site B (**B**), caught and identified in site C (**C**), and in South Africa (**D**). Photography credits: J. Wickel (B), S. Fennessy (C), A. D. Connell (D).

eter rocky outcrop, surrounded by sandy bottom of the slope. The surface of the rocky outcrop was densely covered with scleractinians, sponges and alcyonarians. The sedimentation rate seemed to be high as shown by a thick silty film covering the abiotic parts of the substratum.

The COI sequences of the four *Apolemichthys kingi* from South Africa and the similar-looking individual (BOLD process ID = SAIAD806-14) caught north of Tôlanaro in 2013 were associated to the same BIN BOLD, *i.e.* AAJ1293 (Tab. I). This strongly suggests that all these individuals belong to the same species, *i.e.* *A. kingi*.

DISCUSSION

The comparison of the morphology, colour pattern, and COI sequences confirmed the identification of the Malagasy specimen observed off Sainte Marie Island as *Apolemichthys kingi*. The distribution of this species was previously supposed to be restricted to South Africa and southern Mozambique. The observation of one individual in 2018 on the east coast of Madagascar, and the presence in the BOLD database of a specimen caught in 2013 on the southeastern coast of this country indicate that the range of this species is further extended than expected. These observations also support the hypothesis of a significant larval connectivity between the African continent and the main island of Madagascar (Crochelet *et al.*, 2016). At least, 33 additional fish species with pelagic larvae are distributed in a similar range, *i.e.* restricted to shallow, warm temperate water of southeastern Africa and southern and/or eastern Madagascar (Tab. II). Among these, species like *Chaetodon marleyi* Regan, 1921, *Epinephelus posteli* Fourmanoir & Crosnier, 1964, *Macropharyngodon vivienae* Randall, 1978 or *Paracheilinus hemitaeniatus* Randall & Harmelin-Vivien, 1977 live in habitats very similar to that of *A. kingi*, *i.e.* among rocks with some coral cover. The co-occurrence with *Pomacanthus rhomboides* (Gilchrist & Thompson, 1908) in the same restricted distribution range and habitat is interesting, as both angelfish genera *Apolemichthys* and *Pomacanthus* are represented by a locally endemic species in the southwestern Indian Ocean (distributed in KwaZulu-Natal/South Africa, southern and eastern Madagascar). However, it is recognized that the connectivity between southeastern Africa and southern Madagascar is not the result of a favourable current regime, the southern component of the Agulhas Current following the southeastern African coast to the south (Lutjeharms and Bornman, 2010). On the other hand, this connectivity is proven between southern

Table I. – Public information obtained from the BOLD database (Ratnasingham and Hebert 2007, accessed on 16 March 2018) for *Apolemichthys kingi*. [1]: South African Institute for Aquatic Biodiversity; [2]: Kang-Ning *et al.*, 2015.

BOLD Process ID	Country of origin	Collectors	Identification	Identification provided by	Origin of the information	Barcode Index Number (BIN)
DSFSG960-13	South Africa	A. D. Connell	*Apolemichthys kingi*	A. D. Connell	SAIAB[1]	BOLD:AAJ1293
GBMTG3764-16	South Africa		*Apolemichthys kingi*		Mined from GenBank, NCBI[2]	BOLD:AAJ1293
TZMSA172-04	South Africa	A. D. Connell	*Apolemichthys kingi*	A. D. Connell	SAIAB	BOLD:AAJ1293
TZMSC434-05	South Africa	A. D. Connell	*Apolemichthys kingi*	A. D. Connell	SAIAB	BOLD:AAJ1293
SAIAD806-14	Madagascar	S. Fennessy, B. Mann	*Apolemichthys kingi*	D. Muths	SAIAB	BOLD:AAJ1293

Table II. – Fish species restricted to shallow and warm temperate water of southeastern Africa and/or eastern Madagascar.

Family	Species
Apogonidae	*Foa zuluensis* (Fowler, 1934)
Ariidae	*Galeichthys feliceps* Valenciennes, 1840
Bothidae	*Engyprosopon natalensis* Regan, 1920
Carangidae	*Trachurus delagoa* Nekrasov, 1970
Chaetodontidae	*Chaetodon marleyi* Regan, 1921
Clupeidae	*Gilchristella aestuaria* (Gilchrist, 1913)
Cynoglossidae	*Cynoglossus attenuatus* Gilchrist, 1904
Dichistiidae	*Dichistius multifasciatus* (Pellegrin, 1914)
Gerreidae	*Gerres methueni* Regan, 1920
Gobiidae	*Acentrogobius audax* Smith, 1959
	Croilia mossambica Smith, 1955
	Oxyurichthys nuchalis (Barnard, 1927)
Labridae	*Macropharyngodon vivienae* Randall, 1978
	Paracheilinus hemitaeniatus Randall & Harmelin-Vivien, 1977
	Pseudojuloides polackorum Connell, Victor & Randall, 2015
Leiognathidae	*Leiognathus mazavasaoka* Baldwin & Sparks, 2011
Monacanthidae	*Thamnaconus arenaceus* (Barnard, 1927)
Mullidae	*Parupeneus fraserorum* Randall & King, 2009
Oplegnathidae	*Oplegnathus robinsoni* Regan, 1916
Platycephalidae	*Sorsogona portuguesa* (Smith, 1953)
Pomacanthidae	*Pomacanthus rhomboides* (Gilchrist & Thompson, 1908)
Sciaenidae	*Argyrosomus thorpei* Smith, 1977
	Johnius fuscolineatus (Bonde, 1923)
Scorpaenidae	*Ebosia vespertina* Matsunuma & Motomura, 2015
Serranidae	*Epinephelus posteli* Fourmanoir & Crosnier, 1964
	Serranus knysnaensis Gilchrist, 1904
Sparidae	*Pachymetopon aeneum* (Gilchrist & Thompson, 1908)
	Pachymetopon grande (Günther, 1859)
	Pagellus natalensis Steindachner, 1903
	Polyamblyodon gibbosum (Pellegrin, 1914)
	Polysteganus praeorbitalis (Günther, 1859)
	Spondyliosoma emarginatum (Valenciennes, 1830)
Trichonotidae	*Trichonotus marleyi* (Smith, 1936)

Mozambique and southern Madagascar (Crochelet *et al.*, 2016), supported by the Mozambique Channel Eddies (Lutjeharms and Bornman, 2010). Connectivity between the southern and the eastern coasts of Madagascar is then ensured by the eastern component of the Madagascar Current (Lutjeharms and Bornman, 2010). It is therefore likely that this similar distribution pattern has an origin in southern Mozambique and that the species then migrated to the southeastern coast of Africa and to the southern then eastern coasts of Madagascar.

Apolemichthys kingi was originally described from KwaZulu-Natal (South Africa), from a depth range between 23 m and 30 m (Heemstra, 1984). It was confirmed from the same area by Smith and Heemstra (1986), Lieske and Myers (1994), Heemstra and Heemstra (2004) and listed from Mozambique by Pereira (2000). The Madagascar individual from the southwest shore of Sainte Marie Island was observed at 34 m depth. No depth is associated to the record of specimen SAIAD806-14 caught in southeastern Madagascar but the specimen from South Africa identified as DSFSG960-13 in the BOLD database was caught at –30 m, when those identified as TZMSA172-04 and TZMSC434-05, originating from the same country, were caught at –40 m (BOLD database accessed on 16 March 2018). The depth range of this species may be one of the reasons this species remained unnoticed in Madagascar until recently. This finding indicates that more knowledge about Malagasy fishes may be gained if more UVC are conducted for deeper biotopes and observations associated with genetic studies.

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